

CLAIMS

1 1. An alternator system, having an alternating current (ac) voltage source having at
2 least one rotor, said ac voltage source having an output voltage controllable by a field
3 current thereof and an output, said alternator system comprising:
4 a switched-mode rectifier (SMR) coupled to the ac voltage source and having an
5 output port coupled to an output of the alternator system; and
6 a controller coupled to said switched-mode rectifier so as to provide a controlled
7 pulse sequence synchronized with an angular rotor position of the ac voltage source to
8 activate and deactivate said switched-mode rectifier.

1 2. The system of Claim 1 wherein the controller comprises a PWM generator having
2 a first input adapted to receive a total duty ratio signal synchronized with an angular rotor
3 position of the ac voltage source.

1 3. The system of Claim 2 wherein the controller further comprises:
2 a bounded summation circuit having a first input, a second input, and an output
3 coupled to the first input of the PWM generator;
4 a base duty ratio generator coupled to the first input of the bounded summation
5 circuit; and
6 a timing duty ratio generator coupled to the second input of the bounded
7 summation circuit

1 4. The system of Claim 3 wherein the timing duty ratio generator comprises a first
2 input coupled to an output of a timing reference circuit adapted to receive a timing
3 reference event signal synchronized with the angular rotor position of the ac voltage
4 source.

1 5. The system of Claim 4 wherein the timing reference event signal is provided by
2 one of:

3 a detection of a polarity change in a phase current of said voltage source;
4 a given count from a position encoder coupled to a shaft of the rotor of said
5 voltage source; and
6 a polarity of the voltage across the switched-mode rectifier.

1 6. The system of Claim 1 wherein the controlled pulse sequence comprises a
2 plurality of intervals, the plurality of intervals repeating at a fundamental electrical
3 frequency of said voltage source, each such interval having an adjustable duration and
4 comprising a pulse width modulation (PWM) signal provided by a PWM generator
5 having an input coupled to a summation of a base duty ratio signal having a duty cycle
6 adjustable from zero to unity and a timing duty ratio signal synchronized with the angular
7 rotor position of the ac voltage source.

1 7. The system of Claim 1 wherein a timing reference pulse of the controlled pulse
2 sequence is triggered by an adjustable delay initiated by an event related to a fundamental
3 electrical frequency of said voltage source.

1 8. The system of Claim 1 wherein the controlled pulse sequence comprises a
2 plurality of intervals, the plurality of intervals repeating at a fundamental electrical
3 frequency of said voltage source, each such interval having an adjustable duration and
4 comprising the logical combination of a pulse width modulation (PWM) signal having a
5 duty cycle adjustable from zero to unity and a timing reference pulse signal having a
6 predetermined pulse duration interval less than a fundamental electrical period of said
7 voltage source.

1 9. The system of Claim 8 wherein an initial one of the plurality of intervals is
2 aligned with a timing reference event signal, the pulse signal duration of the initial
3 interval has a zero duration, such that the initial interval provides a pulse delay interval
4 having a predetermined duration, such that a first timing reference pulse signal of the
5 plurality of intervals occurs after the pulse delay interval following the reference signal

6 timing event signal.

1 10. The system of Claim 9 wherein the timing reference event signal is provided by
2 one of:

- 3 a detection of a polarity change in a phase current of said voltage source;
- 4 a given count from a position encoder coupled to a shaft of the rotor of said
- 5 voltage source; and
- 6 a polarity of the voltage across the switched-mode rectifier.

1 11. The system of Claim 1 wherein said controller comprises a microprocessor.

1 12. The system of Claim 1 wherein said controller is a programmable microprocessor
2 operable in response to stored program instructions; and said alternator system further
3 comprises a lookup table which can be interrogated by said programmable
4 microprocessor, to provide information in response to said event, for selectively
5 generating said controlled pulse sequence.

1 13. The system of Claim 1 wherein said controller comprises:
2 a pulse timing reference circuit;
3 a timing reference pulse generator coupled to said pulse timing reference circuit;
4 and
5 a logic element having a first input coupled to an output of said timing reference
6 pulse generator, and having an output coupled to said switched-mode rectifier.

1 14. The system of Claim 13 wherein said controller further comprises a base duty
2 ratio pulse width modulation (PWM) generator having an output coupled to a second
3 input of said logic element.

1 15. The system of Claim 14 wherein the pulse sequence further comprises a plurality
2 of adjustable time periods, wherein each of the plurality of adjustable time periods

3 comprises the output of the base duty ratio PWM generator operating at a predetermined
4 duty ratio for the respective period.

1 16. The system of Claim 14 wherein said base duty ratio PWM generator has an input
2 coupled to a sensor which senses a parameter of a first one of said ac voltage source and
3 an engine and in response thereto said sensor provides a signal representative of the
4 parameter to said base duty ratio PWM generator.

1 17. The system of Claim 16 wherein in response to signal information provided
2 thereto, said base duty ratio PWM generator provides a base duty ratio PWM signal to
3 said logic element which causes the switched-mode rectifier to operate with a particular
4 duty cycle selected to provide a controlled transformation of voltage and current between
5 terminals of the ac voltage source and output terminals of the alternator system and to
6 convert an ac voltage from the ac voltage source to a direct current (dc) voltage.

1 18. The system of Claim 16 wherein said sensor senses at least one of an ac voltage
2 source speed, an ac voltage source fundamental electrical frequency, and an ac voltage
3 source back emf.

1 19. The system of Claim 18 wherein said sensor comprises:
2 a sense winding electromagnetically coupled to the alternating current ac voltage
3 source; and
4 a back emf detection circuit.

1 20. The system of Claim 16 wherein said sensor is coupled to an engine and said
2 sensor senses at least one of an engine speed, and an engine frequency.

1 21. The system of Claim 1 further comprising a field controller comprising:
2 an input port coupled to an output of the controller; and
3 an output port coupled to an input port of a field current regulator to provide the

4 field current to said ac voltage source.

1 22. The system of Claim 22 wherein in response to a sensed output voltage being less
2 than a reference value the controller provides a first output signal to increase the field
3 current to said ac voltage source.

1 23. The system of Claim 21 further a sensor, said controller sensing an output voltage
2 level at the output of said alternator system, and comparing the sensed output voltage
3 level to a reference value, and providing control signals to said field controller in response
4 to the comparison.

1 24. The system of Claim 22 wherein in response to the sensed output voltage being
2 less than the reference value the controller provides a first output signal to increase the
3 field current to said ac voltage source.

1 25. The system of Claim 1 further comprising a fault protection controller having an
2 input port coupled to an output of the alternator system and having an output port coupled
3 to an input of said controller.

1 26. The system of Claim 1 further comprising a thermal sensor disposed on the ac
2 voltage source and having an output port coupled to a thermal sensor input port of said
3 controller.

1 27. A method for controlling an alternator having an alternating current (ac) voltage
2 source, an output voltage controllable by a field current thereof and having a rectifying
3 circuit including a switched mode rectifier, the method comprising:

4 sensing an event synchronized with an angular rotor position of the ac voltage
5 source;

6 generating a controlled pulse sequence in response to sensing the event; and
7 providing said controlled pulse sequence to control the switched mode rectifier.

1 28. The method of Claim 27 wherein generating a controlled pulse sequence
2 comprises:
3 providing a base duty ratio signal;
4 providing a timing duty ratio signal;
5 summing the base duty ratio signal and timing duty ratio signal to provide a total
6 duty ratio signal; and
7 generating a PWM signal having the total duty ratio.

1 29. The method of Claim 27 wherein said event is a timing mark derived from at least
2 one of engine speed, engine frequency, an alternating current (ac) voltage source speed,
3 an ac voltage source frequency and an ac voltage source back emf.

1 30. A rectifier circuit for a multi-phase alternator having at least one phase winding
2 output, the rectifier circuit comprising:
3 at least one connection for receiving the respective at least one phase winding
4 output;
5 a positive output terminal;
6 at least one first diode having a cathode connected to said positive output terminal
7 and an anode connected to a respective one of said at least one phase winding outputs;
8 at least one second diode having a cathode connected to the respective one of said
9 at least one of said phase winding outputs and an anode connected to a reference
10 potential; and
11 at least one reactive device having a first port connected between a respective one
12 of the at least one phase winding outputs and having a second port coupled to a second
13 connection such that conduction times for said first and second diodes are modified
14 resulting in increased output power.

1 31. The rectifier circuit of Claim 30 wherein said reactive device comprises a
2 capacitor.

1 32. The rectifier circuit of Claim 30 wherein the second connection comprises one of:
2 the reference potential;
3 the positive output terminal; and
4 a respective phase winding output.

1 33. The rectifier circuit of Claim 30 further comprising more than one reactive
2 devices wherein the second ports of the more than one reactive devices are connected
3 together to form the second connection.

1 34. The rectifier circuit of Claim 30 wherein said reference potential comprises
2 ground.

1 35. The rectifier circuit of Claim 30 wherein the rectifier circuit further comprises a
2 negative output terminal and said reference potential comprises the negative output
3 terminal.

1 36. A rectifier circuit for a multi-phase alternator having an alternating current (ac)
2 voltage source, a neutral leg and at least one phase winding output, the rectifier circuit
3 comprising:

4 a plurality of connections for receiving the at least one phase winding output;

5 a positive output terminal;

6 a first diode having a cathode connected to said positive output terminal and an
7 anode connected to the neutral leg;

8 a second diode having a cathode connected to neutral leg and an anode connected
9 to a negative output terminal; and

10 at least one reactive device having a second port coupled to the neutral leg and a
11 first port in selective electrical communication with a respective at least one reference
12 potential.

1 37. The system of Claim 36 further comprising:

2 at least one switch having a control terminal, a first terminal switchably connected
3 to the first port of a respective at least one reactive device; and
4 a controller adapted to control said switch such that at least one reactive element
5 can be selectively coupled between the neutral leg and the respective at least one
6 reference potential when said ac voltage source reaches a predetermined rotational speed,
7 such that conduction times for at least one of the first and second diodes are modified
8 resulting in increased output power.

1 38. The rectifier circuit of Claim 36 wherein the respective at least one reference
2 potential comprises at least one of:
3 a ground reference potential;
4 the negative output terminal; and
5 the positive output terminal.

1 39. The rectifier circuit of Claim 36 wherein the negative output terminal is a ground
2 reference potential.

1 40. A rectifier circuit for a multi-phase alternator having a neutral leg and at least one
2 phase winding output, the rectifier circuit comprising:
3 a plurality of connections for receiving the at least one phase winding output;
4 a rectifier having a positive terminal and a negative terminal, coupled to said ac
5 voltage source;
6 a controller so as to provide a controlled pulse sequence;
7 a first switch having a first terminal coupled to the neutral leg and having a
8 second terminal coupled to a first reference potential; and
9 wherein said first switch is coupled to said controller, such that the controller
10 activates and deactivates said first switch.

1 41. The rectifier circuit of Claim 40 wherein the first switch comprises a metal oxide
2 semiconductor field effect transistor (MOSFET).

6 second diode, a cathode of the at least one first diode coupled to an anode of a respective
7 at least one second diode;
8 a circuit coupled to the output voltage port, said circuit comprising:
9 at least one reactive device having a first port and a second port coupled to
10 coupled to an anode of the respective at least one second diode;
11 at least one switch having a control terminal, a first terminal coupled to the
12 first port of a respective at least one reactive device and a second terminal coupled to a
13 reference potential;
14 a controller having an input terminal coupled to an output of a sensor, adapted to
15 control said at least one switch such that a respective at least one reactive element can be
16 selectively coupled between each of a respective phase winding output and the reference
17 potential when said ac voltage source reaches a predetermined rotational speed, such that
18 conduction times for the plurality of first and second diodes are modified resulting in
19 increased output power.

1 49. The rectifier circuit of Claim 48 wherein said reactive device comprises a
2 capacitor.

1 50. The rectifier circuit of Claim 48 wherein said sensor senses at least one of:
2 an ac voltage source speed;
3 an ac voltage source fundamental electrical frequency;
4 an ac voltage source back emf; and
5 a rectifier output voltage.

1 51. The rectifier circuit of Claim 48 wherein the reference potential comprises at least
2 one of:
3 the negative output terminal; and
4 the positive output terminal.